Control
Insect
(Spruce Budworm - 1956)

2-1-56

PLAN FOR THE ENTOMOLOGICAL PHASE

OF THE

1956 SOUTHERN IDAHO SPRUCE BUDWORM CONTROL PROJECT

By

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R. W. BAILEY, DIRECTOR

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PLAN FOR THE ENTOMOLOGICAL PHASE

OF THE 1956 SOUTHERN IDAHO SPRUCE

BUDWORM CONTROL PROJECT

INTRODUCTION

The third large-scale, cooperative, aerial spraying project, and second year of spruce budworm control recommended by the Southern Idaho Forest Pest Action Council (4), will be conducted on approximately 450,000 acres in southern Idaho.

The budworm has probably always been present in the mixed-fir stands of southern Idaho. In 1952 a marked increase in budworm activity was noted. The 1953 aerial and ground survey of damage "disclosed a total of 197,500 acres of mixed fir timber on the Boise, Payette, and Salmon National Forests in which damage by the budworm has reached the stage when further defoliation will result in serious losses" (3). Of this total 86,000 acres were sprayed in 1954 in conjunction with the Pine Butterfly Control Project (3).

Though no report was prepared following the 1954 budworm damage surveys, observations and data showed that the budworm was continuing to cause damage as severe as the previous years. A total of 893,214 acres were sprayed in 1955. An average budworm mortality of 95% was attained on this project (2).

The 1955 budworm damage survey revealed 547,000 acres of budworm infestation varying from moderate to heavy damage. Tree mortality and extensive top killing of immature trees was observed during this survey, especially within the Big Creek Area (1).

The breakdown of acreage by forest is as listed. State-owned lands will increase totals in each unit.

National Forest	Spray Acres
Salmon	138,300
Boise	211,219
Payette	99,120
TOTAL	448,639

RESPONSIBILITIES OF THE DIVISION OF FOREST INSECT RESEARCH

The Division of Timber Management in Region 4 will be responsible for operational phases of the spray project. The Intermountain Station will be responsible for the entomological phases of the project thru the Division of Forest Insect Research.

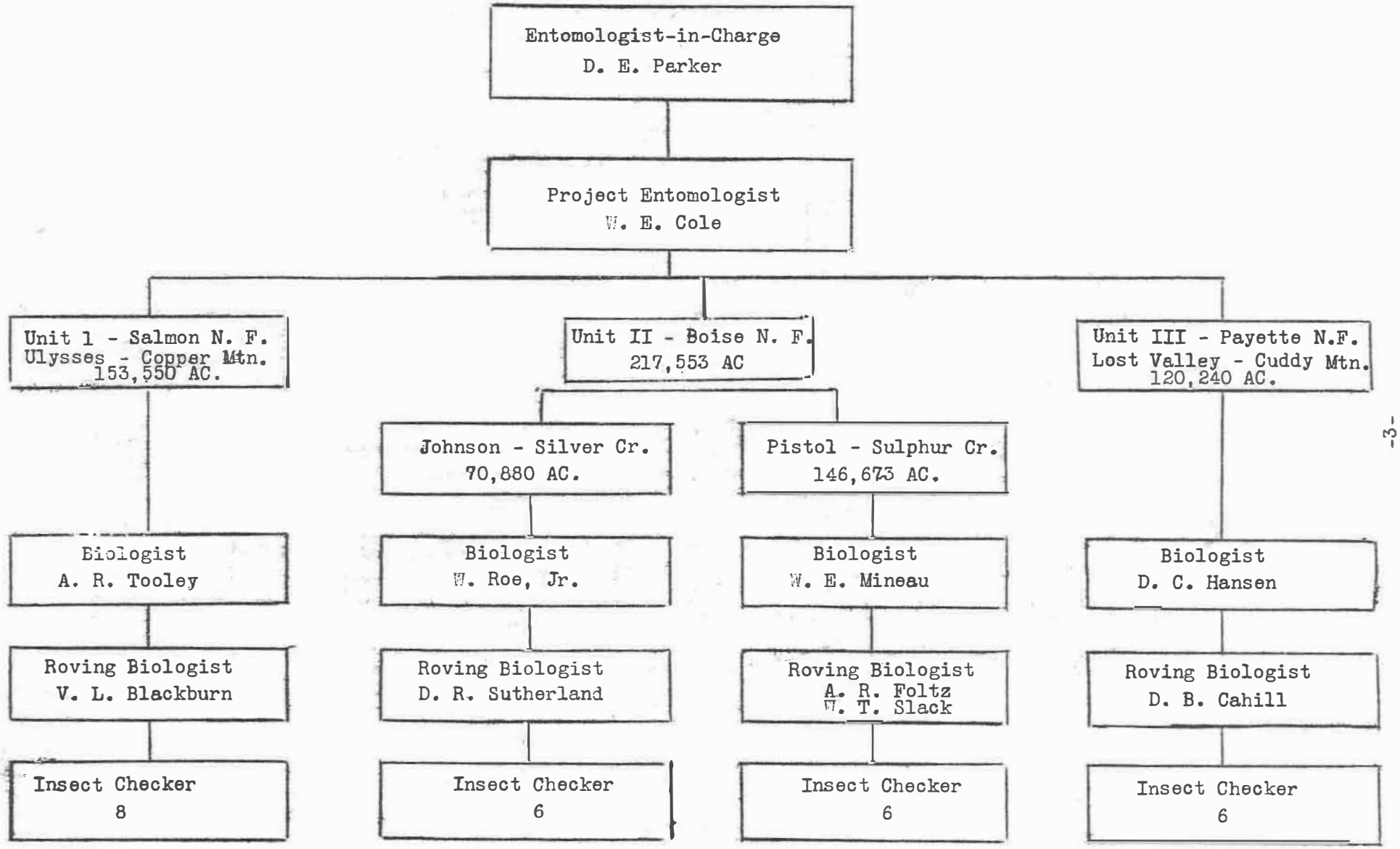
The following plan for the direction of the entomological phase of the 1956 Southern Idaho Spruce Budworm Control Project is patterned after the plan prepared by the Pacific Northwest Forest and Range Experiment Station (5) with slight modifications derived from the experiences of the author.

The Division of Forest Insect Research will not be responsible for the testing of insecticides or the inspections of planes and pilots.

CONDUCT OF ENTOMOLOGICAL PHASES

The Division of Forest Insect Research of the Intermountain Forest and Range Experiment Station will be responsible for determining the start, timing, and sequence of spraying operations and checking the results of the control project.

The 1956 project, from the entomological standpoint, is divided into four control units. The table of organization is as shown.


Entomologist-in-Charge
D. E. Parker
Project Entomologist
W. E. Cole
Unit 1 - Salmon N. F.
Ulysses - Copper Mtn.
153,550 AC.
Unit II - Boise N. F.
217,553 AC
Unit III - Payette N.F.
Lost Valley - Cuddy Mtn.
120,240 AC.
Johnson - Silver Cr.
70,880 AC.
Pistol - Sulphur Cr.
146,673 AC.
Biologist
A. R. Tooley
Biologist
W. Roe, Jr.
Biologist
W. E. Mineau
Biologist
D. C. Hansen
Roving Biologist
V. L. Blackburn
Roving Biologist
D. R. Sutherland
Roving Biologist
A. R. Foltz
W. T. Slack
Roving Biologist
D. B. Cahill
Insect Checker
8
Insect Checker
6
Insect Checker
6
Insect Checker
6

ENTOMOLOGIST IN CHARGE - Mr. D. E. Parker, Chief, Division of Forest Insect Research will be responsible to Mr. R. W. Bailey, Director, Intermountain Forest and Range Experiment Station, for the direction and supervision of all entomological phases of the 1956 project.

PROJECT ENTOMOLOGIST - Mr. W. E. Cole will be the principal Experiment Station representative on the project. He will be directly and only responsible to the Chief of the Division for the field direction of the biological phases of the project. His principal duties will be:

1. To represent the Experiment Station in all matters concerning the biological phases of the 1956 project and work closely with the Project Director.

2. To train, supervise, and be responsible for all work of the Biologists, Roving Biologists, and Insect Checkers.

3. To coordinate all entomological data collected by the Biologists, Roving Biologists, and Insect Checkers.

4. To advise the Project Director and Assistant Project Directors, respectively, as to rate of larval development and start of spraying. At least 10 days notice will be given, confirmed in writing, to the Project Director as to the start of spraying on each unit (not to be construed to mean individual spray blocks) so that all planes can be ordered to their respective airstrips in ample time for the first spraying operations.

5. To plan and direct all entomological field work regarding larval development prior and during the project and larval mortality resulting from spraying operations.

6. To report on the results of the 1956 control project.

BIOLOGISTS - Four Biologists, hired by Research, will be directly responsible to the Project Entomologist. They will report for duty about May 28, 1956, and be fully trained regarding their duties by the Project Entomologist. Each Biologist will be in complete charge of all work pertaining to the entomological phase on his unit. The duties of a Biologist will be:

1. To work harmoniously and on a cooperative level with the Unit Supervisor and other project personnel on his control unit.

2. To become thoroughly familiar with his control unit and spray block boundaries, elevational zone, roads, trails, maps, and communications. This includes aerial surveying

of the assigned unit and any spray block in question. On occasions, situations may occur that can be clarified by an aerial look-see.

3. To confirm all communications--radio messages, verbal reports, telephone conversations, etc., in writing.

4. To select sampling locations for the daily larval development collections.

5. To instruct Insect Checkers in methods of making daily larval collections.

6. To secure spot checks in spray blocks, not being regularly sampled, for supplementary data.

7. To determine rates of larval development by use of comparisons of daily collections with larval standards and head width measurement (Table 1).

8. To keep accurate, neat, and detailed daily records of larval development. Daily collections to be recorded on Form 1, "Spruce Budworm Larval Development Record"; spot collections to be recorded on Form 2, "Spot Check of Larval Development" (Appendix).

9. Daily contact with the Unit Supervisor and confirm in in writing, using Form 4, "Notification of Release of Spray Blocks" (Appendix), regarding the beginning and sequence of spraying operations on each spray block on his unit. When needed, the Project Entomologist will assist the Biologist in setting priorities of spray block release and the need for spot checks. However, the Biologist is in the best position of anyone on the project for such action and his release will be respected.

10. To locate and assist in establishment of representative mortaligy lines within spray blocks and to sample one or two days prior to spraying the area and to re-examine the same lines 10 days after spraying. Records for each mortality line will be kept on Form 3, "Spruce Budworm Mortality Record," (Appendix).

11. To select the blocks and number of lines which will be needed for sampling spray coverage. Record information on Form 5, "Summary of Release of Blocks," (Appendix).

12. To obtain the assistance of the Unit Supervisor in checking larval mortality and spray coverage in blocks where spray deposit cards and observations show inadequate coverage. The need and extent of the area to be resprayed will be determined by these two men with the aid of the Project Entomologist.

13. To report to the Project Entomologist daily (probably by radio) as to rate of larval development, 10-day notification, etc., and submit weekly the cumulative information as shown on Form 5, (Appendix). The summary of this information will be communicated to the Project Entomologist on Thursday morning of each week.

ROVING BIOLOGISTS - Five Roving Biologists, hired by Research, assigned to the 1956 project will work under the supervision and guidance of the Biologist of their respective units. They will report for duty about June 4, 1956, and be fully trained for their duties by the Project Entomologist. The duties of a Roving Biologist will be:

1. To work cooperatively with all personnel on his control unit.

2. To become thoroughly familiar with his control unit--with special reference to trails, roads, altitudinal zones, and spray blocks in the more remote areas.

3. To confirm all communications--radio messages, telephone conversations, verbal reports, etc., in writing.

4. To concentrate on securing spot larval development from the more remote spray blocks and record on Form 2, (Appendix).

5. To obtain notes and biological observations for supplementary information to spot checks in the more remote spray blocks.

6. To establish representative mortality lines within selected remote spray blocks and to sample one or two days prior to spraying these areas and to re-run these same lines 10 days after spraying. Record the data on Form 3, & 3A, (Appendix).

7. To distribute one spray deposit card every five chains along a designated cruise line one day before the area is to be sprayed and to retrieve the same card one or two days after spraying.

8. To assist, aid, and cooperate with the Biologist at all times.

INSECT CHECKERS - The number of Insect Checkers needed for each control unit is shown on the organizational chart. These men will work under the supervision of, and be directly responsible to, the Unit Biologist. They will report to the Project Entomologist about June 4, 1956. Transportation for these men will be furnished by Administration. The duties of an Insect Checker are:

1. To work harmoniously and cooperatively with all project personnel.

2. To become thoroughly familiar with the control unit to which he is assigned--roads, trails, elevational zones, unit and spray block boundaries.

3. To make daily collections of budworm larvae and observations of foliage development at designated points as instructed by the Unit Biologist.

4. To deliver the daily collections at the end of each day to the Biologist.

5. To establish representative mortality lines in spray blocks, as selected by the Unit Biologist, and to sample one or two days prior to spraying.

6. To rerun these same lines ten days after spraying.

7. To distribute one spray deposit card every five chains along a designated cruise line within a spray block one day before the area is sprayed.

8. To collect these same spray deposit cards one or two days after spraying.

9. To deliver the sprayed cards to the Unit Biologist the same day as collected.

10. To assist the Unit Biologist and Unit Supervisor in determining the extent of any area requiring respray. This will be determined from spray deposit cards and observations.

DAILY COLLECTION OF LARVAL SAMPLES

Again this year, the rate of larval development will be determined from the daily collections and head width measurements of budworm larvae (Table 1). The start and sequence of spraying operations in each unit and spray block depends on this determination. The procedure for the daily collection of larval samples is as follows:

1. The Biologists and Roving Biologists will determine as closely as possible the dates on which the overwintering budworm larvae breaks hibernation at various elevations. As soon as the above-named personnel are in the field, sample trees should be established for observation for this determination. The breaking of hibernation is evident when the second instar larvae are seen mining either the needle (found predominantly in Douglas-fir) or the newly opened bud (found predominantly in white fir). This event usually occurs over a period of several days, consequently the date on which the first larvae are seen on or mining the needles or buds will be recorded.

2. The Biologist will establish representative collection plots for each Insect Checker. Spray blocks have been mapped so as to lie within one of two elevational zones--above or below 6,000 feet. The collection plots should be spaced approximately 1500 feet apart, in elevation, within a spray block. It is most desirable to make larval collections daily; however, when all collection plots are in operation, it may become necessary to alternate the day of collecting from any one point.

3. The Biologist will record all collection plots, Form 1 and show their locations on his unit map.

4. Daily collections will begin at the end of the needle or bud mining period (or about one week after breaking hibernation) when most of the larvae have entered the newly opened buds.

5. One hundred larvae will be collected at each collection plot; 50 larvae at each spot check. Branches to be examined should be carefully clipped over, then placed on a collecting cloth. Each bud, or new growth tip, should be examined with a dissecting needle for larvae. Live larvae in all instars and pupae are to be collected and counted. When the required number of larvae have been tallied, the cloth is to be examined and larvae on the cloth counted and added to the collection.

6. Place these larvae and pupae in a vial containing 70% alcohol. Label as to date, collection plot, collector's initial, and elevation. This is highly important to the Biologist.

7. The daily collections are to reach the Biologist at the end of each day.

RELEASE OF SPRAY BLOCKS

"To be fully effective, control of the spruce budworm by aerial applications of DDT must be critically timed during the 10 - 14 day period in any one elevational zone when the larvae are exposed and vulnerable" (5). Control is not effective when the budworm is: (1) mining the needle (or bud) as a 2nd instar larva, (2) protected in tight or swollen buds or when "webbed-in" newly opened buds during the 2nd or 3rd instars, or (3) in the pupal or adult stages.

The following guides will be used by the Biologist in determining spray block release for spraying:

1. Daily comparisons made and tabulated of head width measurements of larvae, from the collections, with Head Width Measurement Standard (Table 1) will be the basis for a spray block release. Observations of foliage development will be used to supplement the above.

2. "When the percentage of 3rd instar larvae appraoches 10 - 15% the start of spraying operations is usually 10 days away. (Quite often this percentage fluctuates for several days around the 10% level and then drops to 5% or below). The Project Director will be notified in writing by the Project Entomologist at this time that all spray planes assigned to the control unit should be ordered to the airstrip and that spraying will probably start on a stated date" (5).

3. "Blocks are usually ready for release when the new growth is expanded and the daily collections show the following percentages:

Instar	Percent
2	0
3	1 - 5
4	40 - 45
5	45 - 50
6	1 - 5 "(5)

An example of larval development prior to start of spraying operations on the 1955 McCall Unit is appended.

4. When larval development is not uniform in an entire block it will be necesaary to: (1) split the block to spray the portion (s) that are ready, or (2) withhold spraying until uniform conditions exist, at which time 50% or more of the larvae may be in the 6th instar. The length of time larvae have been in the 6th instar and daily temperatures determine how long a spray block can be held before spraying. In addition, a delayed spring can mean a wait for a higher percent in the 6th instar prior to pupation.

5. Release of spray blocks should adhere closely to the rate of development as determined by the daily larval samples. As soon as a block is ready for release, it should be released. In any event, priority of spraying will be determined by the date the block was released. Any adjustment in sequence of spraying of blocks released must be done with the approval of the Biologist. This should occur only in cases concerning air safety--that is, to avoid spraying adjacent blocks simultaneously.

6. The Biologist will determine block priorities for spraying and in splitting blocks; consulting with the Unit Supervisor when necessary.

7. Daily contacts with the Unit Supervisor must be made (preferably early each morning) by the Biologist to release new blocks (Appendix) and to ascertain progress of spraying--gallons sprayed, acreage covered, blocks partially sprayed or completed, etc. (Form 6)

MORTALITY LINES

The increase in personnel this year is designed to increase mortality sampling; even so, it will be highly unlikely that all spray blocks can be sampled for larval mortality. However, an attempt will be made to sample mortality in at least 60% of the blocks. The following procedure will be used for sampling larval mortality:

A. BEFORE SPRAYING

1. The Biologist should determine from the Unit Supervisor the probable spraying pattern for most of the spray blocks in the unit, More than likely the spray pattern will follow contours.

2. One or two days before a block is to be sprayed a mortality line will be established and sampled by the Biologist, or Roving Biologist, and one or two Insect Checkers working as a crew. The line will be established perpendicular to

the spray pattern for the block. Mortality lines can be established along roads and trails, thus facilitating more checking. However, mortality lines should not be placed parallel to spray block or control unit boundaries. If a line is established and the block is not sprayed within 5 days, the line should be rerun and a population count taken.

3. A mortality line will usually consists of 10 sample plots. Each plot will be 5 chains (330 feet) apart if paced or 0.2 miles apart if along roads. One out of five lines established should run across entire blocks. Each line will be "strung in" using marking string and each plot marked with tree tags.

4. At each plot, 10 branches, 15 inches long (2 branches from each of 5 trees) are to be carefully clipped over a collecting cloth and every bud (or new growth tip) carefully examined with a dissecting needle. All live larvae, pupae, or freshly emerged pupae cases are to be counted and recorded on Form 3 (Appended). The first 100 larvae on each line are to be preserved in 70% alcohol as the final collection in the spray block.

5. The Biologist will determine the percent of larvae in each instar in the final collection and record the data in the proper space on Form 3.

6. In large blocks two or more mortality lines are desirable. However, the spray blocks for the 1956 control project were purposely kept at an average of 5000 acres to avoid large blocks.

7. The Biologist will keep accurate records of mortality lines on Form 3.

B. AFTER SPRAYING

1. Ten days after the stands around a mortality line have been sprayed, the same line will be rerun by one or two Insect Checkers--one of whom is familiar with the mortality line.

2. At each sampling plot, 20 branches, 15 inches long (4 branches from each of 5 trees) are to be carefully clipped over a collecting cloth and carefully examined for live larvae, pupae, and freshly emerged pupal cases. All surviving larvae, pupae and emerged pupae cases collected on the entire line are to be tallied and preserved in 70% alcohol.

3. The data are to be recorded on Form 3A (Appended), and the mortality percentage computed by the Biologist.

SPRAY DEPOSIT CARDS

Spray deposit cards are used to indicate spray coverage. These cards will be employed in the following manner:

1. The Biologist will determine the location of the card lines. Spray blocks selected for card lines will usually be those blocks not containing mortality lines. If time allows, however, cards should be placed co-incidently with some mortality lines and retrieved as a card line. This will enable a quick check on spray coverage of a mortality line.

2. One or two card lines per block selected should be established. These lines should run perpendicular to the spray pattern and "strung in" with marking string.

3. One spray deposit card is to be placed at an interval of 5 chains along the designated cruise line. These lines should extend across the entire block. The placement of a card should be in a clear, open spot that will not be "shaded" from falling spray droplets.

4. One or two days before a block is to be sprayed, a card line will be "strung in" by an Insect Checker as designated by the Biologist.

5. Within two days after the area around a card line is sprayed, these cards are to be collected by the same Insect Checker who established the line.

6. The Biologist will determine spray coverage from the cards and record such on Form 5. (If inadequate, see "Biologists - Item 12").

REPORTS

The number of reports required during the 1956 project will be kept to a minimum. However, the following are essential:

1. Weekly Progress Report: Each Biologist will submit a brief informal summary of the rate of larval development by instars and collecting points, start and progress of spraying operations and general climatic conditions on

his unit, using Forms 1, 2, and 5. Any "beef" should be listed as well as supplies and equipment needed. This form should be prepared on Wednesday night and promptly mailed to the Project Entomologist - 316 E. Myrtle St., Boise, Idaho. In addition, the summary of this information will be given during the Thursday morning communication (probably by radio). This will enable the Project Entomologist to prepare his Weekly Progress Report and have it distributed by Saturday morning.

2. Bi-Weekly Time Report and Leave Record, (Form FS-26): At the end of each pay period each Biologist and Roving Biologist will complete, sign, and mail promptly his copy of this form to the Project Entomologist. The Insect Checkers will do the same with the exception that their Time Reports will be submitted to their respective Biologist, who, after checking for correctness, will deliver these Time Reports to the respective Forest Supervisor's office - Fiscal Control. This can be done by mail. A sample of a completed Form FS-26 and list of pay periods are appended.

3. Monthly Expense Account: At the end of each month, a summary of the per diem account, purchases, deductions, and miscellaneous expenses must be itemized on the "Itinerary and Memorandum of Official Travel Expenses" form. The Biologists and Roving Biologists will submit their travel expense forms to the Project Entomologist; the Insect Checkers will submit theirs (together with their diary sheets) to the Unit Biologist for delivery to the respective forest offices. The account will be typed and returned for verification, date, and signature (Travel Voucher, Std. Form 1012) before submitting the account for payment. Samples of the completed forms are appended.

4. Vehicle Reports:

   (a) Gasoline reports: If the vehicle is provided by the Experiment Station, all receipts for gasoline, oil, grease jobs, etc., will be submitted bi-weekly with the Time Report. All purchases should be entered in in the operations book at the time of purchase. If the vehicle is provided by administration, other appropriate procedure will be specified.

   (b) Monthly Operation Report: At the end of each month, a report of mileage and operational costs will be submitted to the appropriate agency.

LITERATURE CITED

1. Cole, W. E. 1956. THE SPRUCE BUDWORM IN SOUTHERN IDAHO WITH SPECIAL REFERENCE TO SURVEYS, AUG - SEPT. 1955. Intermountain Forest and Range Experiment Station. Unpublished.

2. Forest Service, 1955. SPRUCE BUDWORM CONTROL PROJECT REPORT, USDA. Intermountain Region, Ogden, Utah. Unpublished.

3. South Idaho Forest Pest Action Council, 1953. PINE BUTTERFLY - SPRUCE BUDWORM CONTROL PLAN FOR 1954 IN SOUTHERN IDAHO. Boise, Idaho. Unpublished.

4. _____, 1955. FOREST INSECT CONDITIONS AND PROPOSED CONTROL PROGRAM FOR 1955 - 1956. Boise, Idaho. Unpublished.

5. Whiteside, J. M., 1955. PLAN FOR THE TECHNICAL DIRECTION OF THE 1955 OREGON SPRUCE BUDWORM CONTROL PROJECT. USDA, FS, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. Unpublished.

A P P E N D I X

EQUIPMENT FOR PERSONNEL

EQUIPMENT AND SUPPLIES: The following list of equipment and supplies will be furnished by the Experiment Station for each Biologist, Roving Biologist and/or Insect Checkers as shown:

1. Laboratory Equipment	Biologist	Roving Biologist	Insect Checker	Total
Alcohol, Ethyl (70%)	1 gal.			4 gal.
Binocular Microscope	1			4
Dissecting Needle	1			4
Forceps, curved	1			4
Flashlight	1			4
Glass Vials and Corks				
24 x 95 mm.	3 gross			12 gross
10 x 75 mm.	2 "			8 "
Larval Standards	1			4
Petri Dish	1			4
Tatum Holder (8 x 10)	1			4
2. Field Equipment				
Altimeter	1	1		9
Bag, carrying, canvas	1	1	1 ea.	35
Collecting cloth	1	1 ea.	1 "	35
Compass, pocket	1	1 "	1 "	35
Cot and mattress	1	1	1	35
Dissecting needle	1	1	1	35
Molding, 15 inches	1	1	1	35
Pouch, belt	1	1	1	35
Pruners, hand	1	1	1	35
Ruler, 6 inch, mm.	1	1		9
Tally register	1	1	1	35
Tree tags	100	200	200	6,600
String	1	1	½	22
3. Supplies				
Plan for Entomological Phase	1	1	1	35
Plan of Operation (Admin.)	1	1	1	35
Control Unit Maps				
2" scale type map	1			4
1/2" scale	1	1		9
1/4" scale	1	1	1	35
Envelopes (franked, 4x5)	50			200
Expense Memo (IF&RES form)	4	4	3	114

Supplies (cont'd)

	Biologist	Roving Biologist	Insect Checker	Total
Form FS-26(Time Report)	12	8	6	244
Form FS-44(Purohase Order)	1 (book)			4 (books)
Form 64 (Office Memo)	1 (pad)			4 (pads)
Form 1	100			400
Form 2		50		250
Form 3	75			300
Form 4	50			200
Form 5	12			48
Form 6	12			48
Form 7	6			24
Notebook	2	2	1	44
Pad, writing (lined)	1	1		9
Paper, carbon	6	1		24
Paper clips	1 box			4 boxes
Pencils and erasers	2	2	2	70
Pen, ballpoint	1	1		9
Soratch pads	1	1		9
Tape, scotch	1 roll			1 roll
4. Communioations				
Radio	1	1	(handy-talkie)	4
5. Transportation				
Vehicle	1	1	1 (per men)^2	17
Horse	1	1	1	15

Table 1.--Larval head width and range for instars of the spruce budworm.

Larval Stage	Width in mm. (aritimetic mean)	Range	Number of Measurements
Second Instar	0.35	0.25 - 0.50	20
Third Instar	0.53	0.40 - 0.70	29
Fourth Instar	0.71	0.65 - 0.80	22
Fifth Instar	1.24	1.20 - 1.50	14
Sixth Instar	2.13	1.80 - 2.50	20

SPRUCE BUDWORM LARVAL DEVELOPMENT RECORD

Forest Nez Perce Unit IV McCall Spray Block 6

Collection Point NP-1 T. 25 N R. 1 W Section 26 Subdivision

Elevation 5000 Exposure Southeast Topographic Position

Date Block Ready for Spraying 7/7/55 Date Block Sprayed 7/8-13/55 Collector DRS

Collection Date	LARVAL INSTARS										PUPAE		
	No. 2		No. 3		No. 4		No. 5		No. 6				
	Larvae	%	Larvae	%	Larvae	%	Larvae	%	Larvae	%	No.	%	Total
14 Jun 55	7	7	64	60	35	33							106
18 Jun 55	7	5	62	49	55	44	2	2					126
21 Jun 55			13	13	73	70	18	17					104
23 Jun 55			5	4	39	32	77	63	1	1			122
28 Jun 55					31	33	61	66	1	1			93
4 July 55					26	21	92	72	9	7			127

NOTES FOR BIOLOGISTS

The Notes for Biologists is designed as a guide and aid for those who, although are well qualified as Unit Biologists, may not be experienced in projects of aerial spraying for insects. These notes are prepared in hopes that they might answer some of the questions that arise on the job and ease a few of the quandries of the vast job ahead of the Unit Biologist.

The position of Unit Biologist on a control project is of high importance. The high quality of work performed by these men is the basic essential for efficient control of a budworm epidemic by aerial spraying.

The essence of such a control project is the proper timing of the release of areas for spraying as determined by the budworm larval development. The majority, if not all, of the decisions determining the release of areas for spraying is made by the Unit Biologist.

A. COLLECTING DATA

1. Larval Development. All too often it is impossible to sample all spray blocks to determine the rate of larval development. In many cases, reasonable comparisons can be made of a known sample plot with an inaccessible area. These comparisons can be made using like elevations, direction the slope is facing, dominant tree species, and other basic ecological factors. In general the rate of larval development will occur in the following order at similar elevations: south facing, west facing, east facing, and north facing slopes last. Of course, larvae will usually develop faster at the lower elevations.

   In comparing larval development with foliage development, remember that after the larvae are within the opened buds a tremendous variation in growth of these two is likely to occur. This variation is directly related to temperatures.

2. Spot Checks. In order to relieve some of the work load of the Unit Biologist, the establishment of daily larval collection plots may be done by the Insect Checker. This can be done only after enough collection plots have been established, under the supervision of the Biologist, to warrant sufficient training. The establishment of these plots by the Insect Checker should be done only at locations designated by the Biologist.

For the first collection only, the Insect Checker should carry Form 1 in the field, fill in the heading complete, and return the Form to the Biologist. This usually eliminates many unfilled blanks which results in loss of information when the data is analyzed.

The above also holds true for all forms; spot checks, mortality, etc. Once the spraying is underway, the sampling activity increases, and regular, daily larval collections will become difficult to obtain. Consequently, spot checking comes into dominance. Utilize the Roving Biologist (or Assistant Biologist) to obtain spot checks in the more inaccessible and hard-to-get-into areas. By this time, enough daily collections should have been made to provide adequate background for comparison with spot checks.

3. Labeling. As with forms, the importance of recording all information required and desired cannot be stressed too greatly. The clarity and neatness of the labels placed within a collection vial is of immense value and importance to the Biologist.

   All labels should be printed with either a pencil or an India ink pen. The ink of a ballpoint pen will fade, becoming impossible to read, and consequently the collection is worthless. Labels should be placed inside each collecting vial and should contain the following information:

   1. Collection plot number (see Coding).
   2. Collector's initial.
   3. Date of collection.
   4. Elevation of collection plot.

4. Coding. The use of the following suggestions for coding of collection plots, spot checks, and mortality lines will facilitate the handling of data in the later analysis through uniformity:

   Forest: Boise - B Division: East Div. - E
   Payette- P West Div. - W
   Salmon - S

   Type of sample: Collecting Plot - CP
   Spot Check - SC
   Mortality Line - M
   Card Line - CL

Numbering will run consecutively for each type of sample. Example:

BW-CP-5 = Boise, West Div., Collection Plot #5.
S- M-2 = Salmon, Mortality Line #2.

If more than one sample of the same type (collecting plot, spot check, etc.) is established within one spray block they should be numbered consecutively - not, for example, 1a and 1b.

B. RELEASING BLOCKS FOR SPRAYING

Spray blocks cannot always be withheld for release until all the foliage is of uniform growth. There is usually too much variation in new growth, both between individuals of the same species and between different species of trees. Here again, the percent of larvae within instars, plus observations of the overall conditions of the spray block in question, is the key to release. Even so, it is the larval development that governs the actual release of spray blocks.

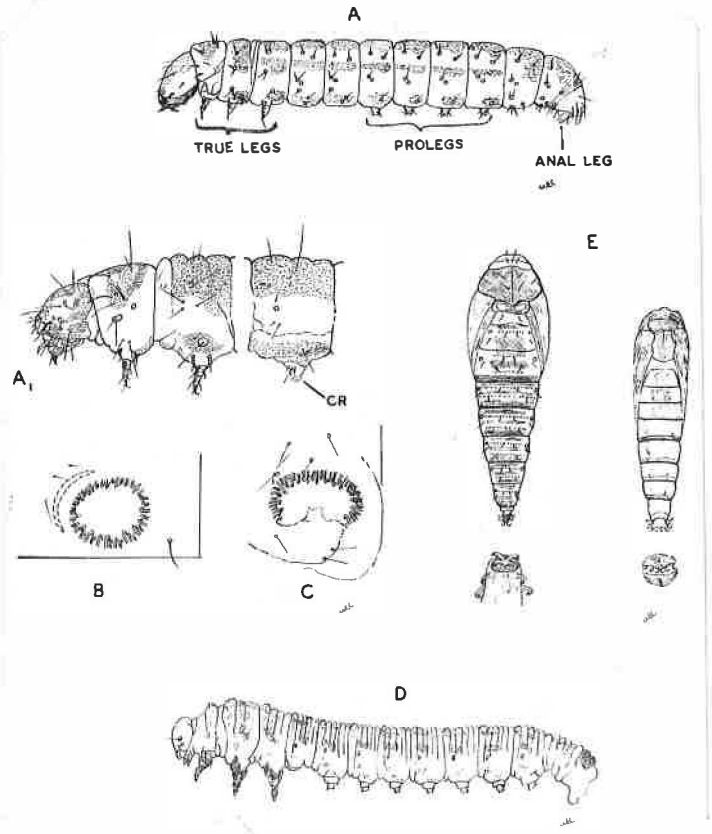
When a spray block is ready for release, as indicated by larval development, release it by priority, using Form 4. Proper spraying, once a block is released, is the responsibility of the Unit Supervisor.

C. MORTALITY LINES.

The entire success of a control project of this type is determined by the overall average percent of budworm larval mortality. Consequently, the obtaining of data for this phase cannot be over-emphasized. Utmost care should be taken to insure accuracy, neatness, and clarity of data gathered on a mortality line. This is particularly true in recognizing empty pupal cases. The majority of pupal cases from the previous year will probably not be present at the time of running a mortality line. However, for purposes of differentiation, the pupal cases remaining from the previous year will be bleached and the amount of webbing will be very slight as compared to pupal cases from the present year. The recognization and counting of empty pupal cases is as important as the remaining live larvae and pupae in determining the percent mortality. An empty, present year pupal case means an adult budworm has escaped the insecticide.

D. ADEQUACY OF SPRAY DEPOSIT.

Each Biologist will be issued one set of the "Spray Deposit Index" with instructions for use. In case of inadequate spray deposit, as indicated by the index, foliage of Oregon grape, wild strawberry, wild rose, ninebark, and dandelion can be used as spray deposit indicators. The oil, within the spray droplets, will "burn" yellowish-brown spots wherever they land on the foliage of these plants. Observations should be made of these indicators when rerunning the mortality lines. These observations should be noted, thus supplementing the percent mortality obtained.



E. INSECT IDENTIFICATION

During past projects some "mistaken Identities" occurred with insects similar to the spruce budworms. Figures A - D are shown as aids in separating these species.

Figure A. Diagrammatic sketch of the spruce budworm larvae showing true legs, prolegs, and anal legs.

Figure A_1. Spruce budworm larvae. Note difference in true leg and proleg and location of crochets (CR).

Figure B. Crochet arrangement of the proleg on the 6th abdominal segment of the spruce budworm larvae. Note - crochets are uniserial (arising from a given line) and biordinal (of two lengths) and in a circle formation.

Figure C. Crochet arrangement of the anal leg of the spruce budworm larvae.

Figure D. Typical sawfly larvae. Note - only one abdominal segment between true legs and prolegs and number of prolegs; spruce budworm larvae possess two abdominal segments between true legs and prolegs.

Figure E. Pupae of spruce budworm (left) and Diaryctria spp. (right). Note - arrangement of "hooks" on anal segments of both species.

Calibrating measuring reticules. The reticule for eyepieces of microscopes is issued for measuring head capsule widths of spruce budworm larvae for classification as to instars.

Each scale has to be calibrated for use with each combination of objective and eyepiece. To calibrate, focus on a millimeter scale placed on the stage, and move it until one of the graduations corresponds exactly with one of the divisions of the eyepiece micrometer. The true distance (X) seen on the stage micrometer, which corresponds to the number of divisions (Y) of the eyepiece micrometer, is then read and dividing this true distance by the number of divisions of the eyepiece micrometer, will equal the distance each subtends ($C = X/Y$). The number of divisions covered by the specimen multiplied by the calibration constant gives the length of the specimen.

Instars. Moulting is the process of transformation when the larva changes from one instar to another. Many of the collections will contain larvae that are in some phase of moulting. Each phase can be differentiated accordingly, which in turn, may aid in classifying to instar the borderline larvae when using the "Tables of Head Width Measurements."

a. Prior to Moulting. During the phase the head of a larva will appear slightly smaller in diameter than the body. In most cases the old larval skin will begin to be pushed back from the head. This will appear similar to a black thoracic shield.

b. Immediately after Moulting. The old larval skin and head capsule has been shed. Usually the head will appear whitish or flesh color and be somewhat larger than the body.

c. During Moulting. During the actual moulting various stages between item (a) and (b) will be found. In a few cases the head capsule can be found partially off of the head, while in others the old larval skin will be found completely intact and moulted.

FORM I

SPRUCE BUDWORM LARVAL DEVELOPMENT RECORD

Forest _____ Unit _____ Spray Block _____

Collection Point _____ T. _____ R. _____ Section _____ Subdivision _____

Elevation _____ Exposure _____ Topographic Position _____

Date Block Released for Spraying _____ Date Block Sprayed _____ Collector _____

Collection Date	Tree Sp	LARVAL INSTARS										PUPAE		Total
		2		3		4		5		6				
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	

FORM 2

SPOT CHECK OF LARVAL DEVELOPMENT

Forest_____

Unit No._____

Collector_____

Date	Block	Elev.	Date Relsd	Date(s) Sprayed	Larval Instars												Total	Tree Sp.	Ave. New Growth Length
					2		3		4		5		6		Pupae				
					No	%	No	%	No	%	No	%	No	%	No	%			

FORM 3

SPRUCE BUDWORM MORTALITY RECORD

Forest _____ Control Unit _____ Spray Block _____ Line No. _____

Starting Point _____ Direction Run _____

Date Block Released _____ Date(s) Block Sprayed _____ Plot ___ Plane ___

BEFORE SPRAYING

Date Collected _____ Collector _____

TREE No.	Sp.	Stage	Number of Specimen / Sample Plot 1	2	3	4	5	6	7	8	9	10	Total
1		Larvae											
		Pupae											
2		Larvae											
		Pupae											
3		Larvae											
		Pupae											
4		Larvae											
		Pupae											
5		Larvae											
		Pupae											
Plot Total		Larvae											
		Pupae											
Grand Total		Larvae											
		Pupae											

FORM 3A

SPRUCE BUDWORM MORTALITY RECORD

Forest _____ Control Unit_____ Spray Block _____ Line No._____

Starting Point _____ Direction Run _____

Date Block Released _____Date(s) Block Sprayed_____Plot____Plane_____

AFTER SPRAYING*

Date Collected_____Collector _____

TREE No.	Sp.	Stage	Number of Specimen / Sample Plot 1	2	3	4	5	6	7	8	9	10	Total
1		Larvae											
		Pupae											
		Emerged											
2		Larvae											
		Pupae											
		Emerged											
3		Larvae											
		Pupae											
		Emerged											
4		Larvae											
		Pupae											
		Emerged											
5		Larvae											
		Pupae											
		Emerged											
Plot Total		Larvae											
		Pupae											
		Emerged											
Grand Total		Larvae											
		Pupae											
		Emerged											

Last Larval Development Before Spraying

	2	3	4	5	6	Pupae	Total
No.							
%							

*No. of Branches = Twice No. Before Spraying

$$\% \text{ Mortality} = \frac{\text{Before Spray Count} \times 2 - \text{After Spray Count}}{(\text{Before Spray Count} \times 2)} =$$

_____ = _____ = _____%

FORM 4

NOTIFICATION OF RELEASE OF SPRAY BLOCKS

The following desoribed area(s) is released for spraying in the priority as listed on _____(date):

Priority	Block	Total Acres	Area Release	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				

Unless otherwise stated, the lower elevations should be sprayed first should the period of spraying a block exceed one day.

(Signed)_____

(Title) _____

(Date) _____

If this is a verification of a release by earlier communication, such release was given by _____(name) on _____(date) by _____(Communication.

FORM 5

SUMMARY OF RELEASE OF BLOCKS: PERIOD OF SPRAYING AND
SPRAY DEPOSIT AND MORTALITY SAMPLING

Unit No. _____

Biologist _____

Spray Block No.	Spray Ac.	Non-Spray Ac.	Total Block Ac.	Released Order	Date Relsd.	Date Spray Began	Date Spray Ended	SPRAY DEPOSIT CARDS			Date Re-spray	Re-spray Ac.				Date All Work Ended
								Date Out	Date In	Adequacy of Deposit			Date of Pre-spray Ct.	Date of Post spray Ct.	% Mor-tality	

FORM 6

SUMMARY OF RELEASE OF BLOCKS (UNIT SUPERVISOR)

Spray Block No.	Spray Ac.	Non Spray Ac.	Total Block Ac.	Relse Order	Date Relse	Date Spray Began	Date Spray Ended	Spray Dep. Cards	Date Re-Spray	Re-Spray Ac.	Mort. Line	% Mort.

FORM 7

RECORD OF DAILY SPRAY OUTPUT

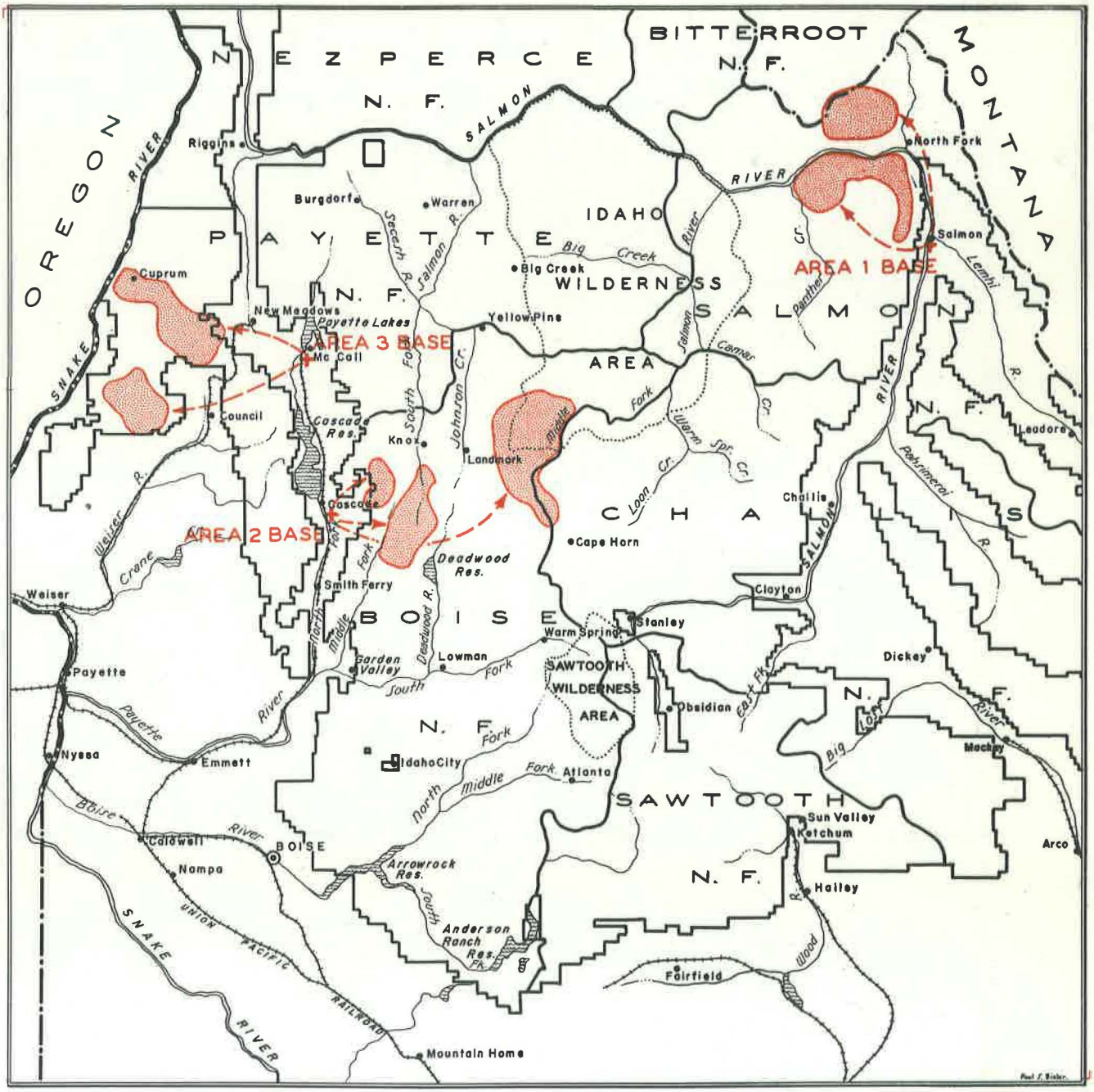
Unit No. _____

Biologist _____

Date	Daily Total Gallons Sprayed	Cumulative Gallons Sprayed	Gallons Remaining to be Sprayed

LIST OF PAY PERIODS

Pay Period No.	Dates
10	May 6 - May 19
11	May 20 - June 2
12	June 3 - June 16
13	June 17 - June 30
14	July 1 - July 14
15	July 15 - July 28
16	July 29 - Aug. 11
17	Aug. 12 - Aug. 25



SPRUCE BUDWORM CONTROL PROJECT

SOUTHWESTERN IDAHO

BOISE, PAYETTE & SALMON NATIONAL FORESTS

1956

SCALE 0 10 20 30 40 MILES

LEGEND

CONTROL AREAS, 1956

+ BASE LANDING FIELDS & AIRSTRIPS.

U.S.F.S. OGDEN FEB. 1956.